Appendix B

DESCRIPTION OF THE ANALYSIS PROCESS

INTRODUCTION

Appendix B presents a technical discussion of the analysis process and computer models used in the revision planning effort. The appendix focuses on the quantitative methods used to perform the analysis and documents how the analysis was done.

The Forest's major planning goal is to provide enough information to help decision makers and the public determine which combinations of goods, services, and land allocations will maximize net public benefits. The regulations (36 CFR 219) developed under the National Forest Management Act (NFMA 1976) provide the analytical framework within which these decisions are made.

The NFMA and its regulations also state that the requirements of the National Environmental Policy Act (NEPA) and its regulations (40 CFR 1500-1508) must be applied in the analytical process. The NEPA regulations require that the environmental effects of a proposed action and alternatives to that proposed action must be disclosed in an environmental impact statement (EIS).

Information presented in this appendix supplements the broader and less technical descriptions included in the body of the EIS. This discussion includes basic assumptions, modeling components and inputs, rules, methods, and constraints. Additional information and documents used in the analysis process are contained in the planning records. The planning record in its entirety is incorporated here by reference.

The results from the modeling process are estimates of what can be expected if alternatives are implemented and facilitate comparison of alternatives.

THE 10-STEP PLANNING PROCESS

Land and resource management planning requires that processes formally used to make individual resource decisions be combined into integrated management decisions. It also requires that mathematical modeling techniques be used to identify the most economically efficient solution to meet the goals and objectives of any alternative.

The 10-step process defined in the NFMA regulations was followed. This appendix is concerned with describing the analysis phase of this process, which is steps 2, 3, 4, 5, and 6. Steps 1, 7, and 8 are described in Chapters 1 and 2 of this EIS. Plan implementation (Step 9) and monitoring (Step 10), are discussed in the revised Forest Plan. A brief discussion of the 10-step process follows:

STEP 1: Identification of Purpose and Need: issues, concern, and opportunities – The Forest interdisciplinary team assessed changes in public issues, management concerns and resource use and developmental opportunities (ICOS) since the Forest plan was initially developed and subsequently amended. Chapter 1 of the EIS documents this step.

STEP 2: Planning Criteria – Criteria are designed to guide the collection and use of inventory data and information, the analysis of the management situation; and the design, formulation, and evaluation of alternatives. This step establishes guidelines for accomplishing the next five steps. The work plan and other process records document this step.

STEP 3: Inventory Data and Information Collection – The kind of data and information needed is determined in Step 2 based on the issues, concerns, and opportunities identified and the resulting assessment of the management situation and determination of what needs to change. Data collection is part of normal forest operations. Existing data is used whenever possible and supplemented with new data, when practicable, if new data will contribute to more responsive analysis. Data accuracy is continually evaluated. Much of this data and background documentation is part of the planning process records on file in the Supervisor's Office.

STEP 4: Analysis of the Management Situation - This step consists of assessing the existing situation on the Forest and determining opportunities for resolving issues and concerns. This information provides the basis for formulating an appropriate range of reasonable alternatives. This analysis brings existing information together, puts it into a total Forest perspective, and examines the range of possible situations to resource issues. It examines supply potentials and market assessments for goods and services, and determines suitability and feasibility for meeting needs. Other objectives of the analysis of the management situation include the following:

- Assessing current direction including estimates of goods and services most likely to be provided if current direction is continued.
- Assessing demand for goods and services from National Forest lands.
- Determining if there is a need to change current management direction.

STEP 5: Formulation of Alternatives - A reasonable range of alternatives is formulated according to NEPA procedures. Alternatives are formulated to assist in identifying one that comes nearest to maximizing NPB. They provide for the resolution of significant issues and concerns identified in Step 1. The alternatives reflect a range of resource management programs. Each identified major public issue and management concern is addressed in different ways in the alternatives. The programs and land allocations in each alternative represent the most cost-efficient way of attaining the goals and objectives for that alternative. Both priced and non-priced goods and services (outputs) are considered in formulating each alternative.

STEP 6: Estimated Effects of Alternatives -- The physical, biological, economical and social effects of implementing the alternatives are considered in detail to respond to the issues and need for change. The Spectrum model estimates some, but not all, of the economic and physical effects. Other effects examined outside the model include ecological and social considerations. The effects of the alternatives are displayed in Chapter 2 and 3 of this EIS.

STEP 7: Evaluation of Alternatives - Significant physical, biological, economical and social effects of implementing alternatives are used to evaluate the alternatives and compare them with each other. Typically, each alternative can be judged on how it addresses the significant issues identified in Chapter 1 of the EIS. Chapter 2 of the EIS summarizes the comparisons of the alternatives with the issues.

STEP 8: Preferred Alternative - The Forest Supervisor reviews the Interdisciplinary (ID) Team evaluation of each alternative and the public's issues and concerns. The Forest Supervisor then recommends a preferred alternative to the Regional Forester. The Regional Forester either selects the Forest Supervisor's recommendation, another alternative, or modifies the alternative recommended by the Forest Supervisor. This alternative is described as the preferred alternative in this EIS and is displayed in the Proposed Revised Forest Plan. The Forest Service's preferred alternative is announced in Chapter 2 of the DEIS. Public comments are then solicited and considered in finalizing the revised Forest Plan and EIS.

STEP 9: Plan Approval and Implementation - After the ID Team has reviewed the public's comments and incorporated any necessary changes into the EIS or revised Forest Plan, the Regional Forester reviews and approves the Revised Forest Plan and Final Environmental Impact Statement. A Record of Decision (ROD) documents this step.

STEP 10: Monitoring and Evaluation - The Revised Forest Plan establishes a system of measuring, on a sample basis, actual activities and their effects, and compares these results with projections contained in the Revised Forest Plan. Monitoring and evaluation comprise an essential feedback mechanism to ensure the Revised Forest Plan is dynamic and responsive to change. Chapter 4 of the Revised Forest Plan displays the Monitoring and Evaluation program.

PLANNING CRITERIA (STEP 2)

The NFMA regulations require planning criteria be developed to guide each step in the planning process. Process criteria are the standard rules and tests to guide and measure the effectiveness of the planning process. Criteria apply to collection and use of inventory data and information; analysis of the management situation; and the design, formulation and evaluation of alternatives.

Planning criteria are based on the following:

- Laws, Executive Orders, regulations and agency policy as set forth in the Forest Service Manual.
- Goals and objectives in the Forest Service Strategic Plan.
- Recommendations and assumptions developed from public issues, management concerns and resource use and development opportunities.
- The plans and programs of other federal agencies, state and local governments and Indian tribes.
- Ecological, technical and economical factors.
- The resource integration and management requirements in 36 CFR. 219.13 through 219.27.

In addition, the Land and Resource Management Planning Handbook (FSH 1909.12) requires the following criteria also be applied:

- Alternatives are technically possible to implement.
- Alternatives meet management requirements or standards.
- Various levels of multiple-use objectives and outputs are achieved.

INVENTORY DATA AND INFORMATION COLLECTION (STEP 3)

The ID team, with assistance from resource specialists and district personnel, collected data, maps, graphic material and exp1anatory aids appropriate for addressing the issues and conducting required analysis. Inventory was done to the detail necessary to support the management decisions to be made.

The following criteria were applied to all elements in the inventory phase:

1) Use existing data unless it is inadequate.
2) New data and information will be collected on an as needed basis.
3) Sources of information and data will be documented in the planning records.
4) The Geographic Information System (GIS) system will be used for map storage and manipulation, spatial analysis and generating maps for the Forest Plan.
5) The attribute system in GIS will be used when possible to store, manage and display data associated with mapping units.
6) Only information stored in GIS will be used to develop capability and management areas for use in the Spectrum scheduling model.
7) Where assumptions are used in lieu of specific data or information, the following will occur:
    a) Identify analytical techniques and associated assumptions used.
    b) Document why each assumption was used.
    c) State the basis upon which the analytical techniques and assumptions were selected (identify advantages and disadvantages of each).

ANALYSIS OF THE MANAGEMENT SITUATION (STEP 4)

In addition to the emerging issues, the need for change was identified through an analysis of the management situation. This analysis considers results of monitoring, other policy and direction since 1985, the 5-Year Review, the current condition of the resources and supply and demand factors to determine the need for change in management direction, and the ability of the planning area covered by the Forest Plan to supply goods and services. It provides a basis for formulating a broad range of reasonable alternatives. A summary of the major finding of this analysis is located in the *Revised Forest Plan.* The complete Analysis of the Management Situation documents are available at the Supervisor's Office and temporarily through the comment period on the Forest's website (www.southernregion.fs.fed.us/boone/planning).

BUDGET LEVELS ASSUMED FOR EACH ALTERNATIVE

To develop projected budget needs for each Alternative, several assumptions had to be made. Forest Plan Goals and Objectives can be used to help guide the distribution of budget allocations to individual program areas, such as recreation, wildlife, soil/water/air, etc. However, Forest Plans have little influence over the total budget allocated to a National Forest.

To verify feasibility of Alternatives considered in detail, a total-budget estimate was made for each. This was followed by a determination of the best distribution of program budget allocations to meet the needs and emphases of the various Alternatives. A review of the Daniel Boone's budget allocations for the past 10 years shows that, when adjusted for inflation, allocations changed relatively little. An average of total budget allocations for Fiscal Years 2001 and 2002 was then chosen as the baseline, assuming an increase of no more than 10 percent over the baseline during the first decade of the planning period.

With the maximum increase of 10 percent as a constraint the planning team estimated the difference in total budget that could be expected based on the emphasis of the alternatives. Using the estimated total budget as a constraint, the distribution of funds in budget areas such as recreation, timber and wildlife were estimated. Considerations used in developing these distributions included the Forestwide Goals and Objectives, Prescription Area allocations, projected management activities, and the results generated by the linear program model (Spectrum).

Table B - 1 displays the budget distributions and totals that were assumed for each Alternative.

With four exceptions, program budget projections vary three percentage points or less among Alternatives. The greatest contrast can be seen in the Timber Program, which would account for 12 percent of the total budget in Alternative A. In the "custodial" Alternative, B-1, the Timber Program would consume only 2 percent of the Forest budget. Alternative E-1, the "production" Alternative, Timber would take up 10 percent of the budget, while the other three Alternatives would each account for 9 percent.

For the Wildlife Program budget, the greatest variation between two Alternatives can be found in Alternatives A and B-1, which would account for 7 and 2 percent, respectively. The remaining Alternatives would take up 5 percent, except for Alternative C, which receive 6 percent of the total program budget.

The next greatest budget contrast among Alternatives occurs in the Engineering Program, which would receive 15 percent of the program budget under Alternative B-1 but only 10 percent under Alternatives A, C, and C-1. Alternatives D and E-1 would allocate 11 percent to the Engineering program.

Table B - 1. Estimated Program Budget distributions in thousands of dollars and percent of total by Alternative

	1985 Forest Plan		Current Forest Plan		Alternative A		B-1		C		C-1		D		E-1	
Program Area	Allocation	% of Total	Allocation	% of Total	Allocation	% of Total	Allocation	% of Total	Allocation	% of Total	Allocation	% of Total	Allocation	% of Total	Allocation	% of Total
Planning/Inventory/ Monitoring	$0	0	$1,009	10	$1,149	10	$1,149	12	$1,149	10	$1,149	10	$1,149	10	$1,149	10
Recreation	$5,211	25	$3,277	31	$3,238	28	$3,447	35	$3,447	31	$3,655	32	$3,791	33	$3,551	31
Wildlife	$781	4	$564	5	$836	7	$209	2	$627	6	$627	5	$522	5	$522	5
Range	$29	0	$0	0	$0	0	$0	0	$0	0	$0	0	$0	0	$0	0
Timber	$5,206	25	$1,010	10	$1,358	12	$209	2	$1,044	9	$1,044	9	$1,044	9	$1,149	10
Soil/Air/Water	$1,066	5	$259	2	$313	3	$418	4	$418	4	$418	4	$418	4	$313	3
Minerals	$696	3	$289	3	$313	3	$209	2	$313	3	$313	3	$313	3	$627	5
Lands	$1,355	6	$367	4	$418	4	$313	3	$418	4	$418	4	$418	4	$522	5
Engineering	$5,525	26	$1,141	11	$1,149	10	$1,462	15	$1,149	10	$1,149	10	$1,253	11	$1,253	11
Fire	$1,104	5	$2,220	21	$2,193	19	$2,089	22	$2,245	20	$2,245	20	$2,245	20	$2,089	18
Forest Health	$0	0	$308	3	$522	5	$209	2	$418	4	$418	4	$313	3	$313	3
Total	$20,973	100	$10,444	100	$11,489	100	$9,714	100	$11,228	100	$11,436	100	$11,466	100	$11,488	100

Note: The above Budgets reflect average annual allocations for the first decade (in 2000 dollars) expected for the natural resource management program areas, based upon a constrained budget of no more than 10% increase over the planning period. In a given fiscal year the total budget allocation for the Daniel Boone National Forest will also include allocations for such things as law enforcement, quarters maintenance, and fleet equipment. These programs were not addressed in developing the budget distributions for natural resource programs.

FOREST ACTIVITY SCHEDULING MODEL (SPECTRUM)

This section documents the work associated with the formulation and analysis of the forest activity-scheduling model for the Daniel Boone National Forest[1].

The forest planning analysis problem can be stated as follows: Given a fixed area of land, what activities should be assigned to each land unit over the next 150 years to achieve the desired future conditions and still meet all physical, operational and regulatory constraints. To do this, the forest land area is divided into smaller homogeneous areas called analysis units. The planning horizon of 150 years is divided into fifteen 10-year periods. A computer program called Spectrum is used to analyze the forest planning alternatives. Spectrum is a decision support model, developed and supported by the USDA Forest Service[2], which can simultaneously analyze the trade off between the many goals, constraints, management activities, timing options and land types which are necessary to manage a large forest. Spectrum uses a linear program software program called C-Whiz, which in turn uses the Simplex method. The following discussions describe the model formulation, the data used, the activities that are to be applied, differences between alternatives, and some of the results.

Prior to the Spectrum analysis there was considerable work done to prepare data for input to the Spectrum model. This work included: identification of lands tentatively suitable for timber harvest (per 36 CFR 219.14); analysis unit development; timber yield table development; economic information development; management prescription development; and determination of suitable acreage within each alternative. Identification of lands tentatively suitable for timber production and the determination of suitable timberland within each alternative are discussed in chapter 3 (Timber Products).

DEVELOPMENT OF ANALYSIS UNITS

The Daniel Boone's land base, which is inventoried and tracked in the CISC database[3], was classified by using the six levels of information summarized in Table B - 2. With these six levels there are 338,688 possible combinations, however, when we overlay the six layers of information on the Daniel Boone National Forest we find that there are 6,537 unique analysis units.

Table B - 2. Identification Levels used to classify the DBNF land base for analysis

Level	Description	Number of Categories	Example of code
1	Location by District and watershed	56	Lon-18 – is for London District Watershed 18
2	Access Class	2	Road-cst – is for areas which require additional road construction in order to access
3	Forest type working group	8	XMOG – is for xeric oak stands of good site quality.
4	Age of stand	14	70 – is for stands that are currently 70 to 80 years old.
5	Slope	2	Logcst – is for areas that are greater than 40% slope.
6	Administrative classification	12	BAT – areas with significant bat caves buffered with a one-mile radius.

[1] Primary author: Dr. Joseph P. Roise of North Carolina State University.

[2] Forest Management Service Center, Fort Collins, CO.

[3] Continuous Inventory of Stand Conditions (CISC) database, version 4.02, January 1997.

Table B - 3 displays the acreages in each level one category (district and watershed combinations). These areas are important because they can be easily located on the forest. The other five level identifiers, while they can be located on the forest, are not as easy to locate. This is because they are not necessarily contiguous land areas.

Table B - 3. Level 1 identifiers – Location on the DBNF by District[1] and watershed

Level 1 Identifier	Acres	Level 1 Identifier	Acres	Level 1 Identifier	Acres	Level 1 Identifier	Acres
lon-13	2,415	mor-0	85	som-29	11,105	ste-37	3,976
lon-14	19,500	mor-2	34,568	som-33	2,124	ste-38	19,968
lon-15	918	mor-3	14,856	som-36	20,579	ste-41	18,579
lon-17	6,044	mor-4	27,262	som-37	11,509	ste-42	3,839
lon-18	5,895	mor-5	10,013	som-38	11,919	ste-43	10,361
lon-19	14,589	mor-6	15,434	som-39	10,189	ste-44	10,098
lon-20	24,072	mor-7	1,962	som-41	18	ste-45	15,929
lon-23	5,419	red-21	14,031	sta-10	8,462	ste-46	24,163
lon-24	996	red-22	3,814	sta-11	1,966	ste-47	1,494
lon-29	20,208	red-25	9,579	sta-12	4,078	ste-48	1,802
lon-32	10,015	red-26	6,381	sta-13	1,180	ste-49	1,184
lon-34	11,671	red-27	20,206	sta-16	309		
lon-35	15,857	red-28	74,986	sta-6	127		
lon-37	20,647	red-30	105	sta-8	30,037		
lon-40	4,333	red-31	12,522	sta-9	1,435		

[1] Districts are abbreviated as:
lon = London Ranger District
mor = Morehead Ranger District
red = Redbird Ranger District
som = Somerset Ranger District
sta = Stanton Ranger District
ste = Stearns Ranger District

The next set of identifiers (Level 2) is for areas that need additional access roads for activities to take place and those that do not need additional access roads.

Table B - 4. Level 2 identifiers - Access class for lands on the DBNF

Level 2 Identifier[1]	Description	Acres
None	Needs no additional road construction for access.	382,173
rd-cst	Needs additional road construction for access.	252,640

The Level 3 identifiers (Table B - 5) are for forest type working group and in the case of oak types, some information about site productivity is maintained.

Table B - 5. Level 3 identifiers - Forest type groups found on the DBNF

Level 3 Identifier	Description of Type	Acres
BUG47	Pine with heavy southern pine beetle damage	36,695
BUG53	Pine-hardwood with southern pine beetle damage	55,418
MM-F	Mixed mesophytic forest	158,837
O-YP	Oak - yellow pine (stands having 30-49% pine)	58,526
P-PO	Pine and Pine-oak (stands having 50-100% pine)	1,210
WP-H	White pine and hemlock	24,985
XMOG	Mesic oak, good site quality	24,217
XMOP	Xeric oak, poor site quality	274,925

The Level 4 identifier is for the age of the forest stands (Table B - 6). The current age class distribution plays an important roll in what can be achieved on the forest during the next several decades. Note the large acreage in the "0" (0-9) age-class. Just over 40,000 acres of this is pine forestland damaged by the southern pine beetle. This southern pine beetle attack will affect the forest structure and environment for years to come. **Figure B - 1** next to the table is a graphic display of the 1998 age-class distribution, adjusted for the loss of pine due to the pine beetle outbreak in 2000 and 2001.

Table B - 6. Level 4 identifier – Stand age for stands within the DBNF

Level 4 Identifier	Age Description[1]	Acres
0	0 thru 9	62,660
10	10 thru 19	43,708
20	20 thru 29	44,779
30	30 thru 39	38,536
40	40 thru 49	24,125
50	50 thru 59	28,578
60	60 thru 69	56,170
70	70 thru 79	88,304
80	80 thru 89	87,938
90	90 thru 99	76,975
100	100 thru 109	47,994
110	110 thru 119	24,473
120	120 thru 129	6,889
130	130 and up	3,684

[1] In years

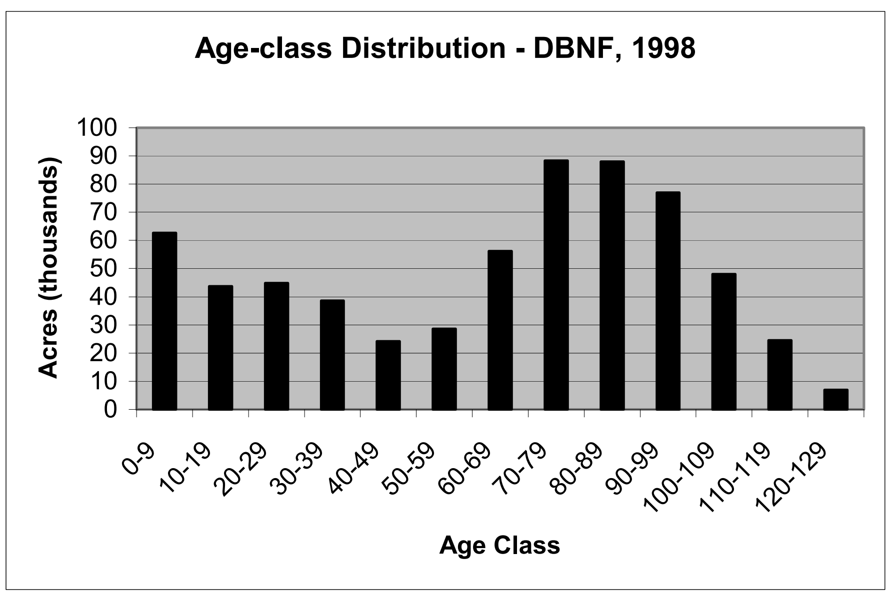

Figure B - 1. Age Class Distribution

The Level 5 identifier is for slope class (Table B - 7). The major effect of slope in the analysis model is to adjust logging costs when the ground gets steeper.

Table B - 7. Level 5 identifier – Slope class for lands within the DBNF

Level 5 Identifier	Description	Acres
logcst	Slopes greater than or equal to 40%	65,194
none	Slopes less than 40%	569,619

The Level 6 identifiers are for those Prescription Areas that are unsuitable for timber production. Various combinations of these were used, based on the Prescription Areas assigned to each alternative as shown in Chapter 2. Some of these areas, such as the administratively withdrawn land classes, are excluded from timber production in all alternatives.

Table B - 8. Level 6 identifiers – Administrative classification

Level 6 Identifier	Description	Acres
Bats	Significant bat cave areas buffered with a one mile radius	4,907
Cliff	Cliffline when not located within another level 6 identifier	56,259
Grouse	Ruffed grouse emphasis Area	9,309
NASA	Natural Arch Scenic Area	1,055
NONE	Not classified in other areas.	440,343
OLDGRO	Designated old-growth and potential old-growth forests	16,721
PotWSR	Potential Wild Scenic River	12,309
PRNAEL	Potential research natural area Elijah Branch	330
PRNATH	Potential research natural area Tight Hollow	308
RIPARI	Riparian when not located within other level 6 identifier, except cliff	70,932
SubRRG	Red River Gorge Geological Area	15,343
Swap	Source water protection level 1	5,412
WSRREC	Red River Gorge/Potential Wild Scenic River	1,585

DEVELOPMENT OF TIMBER STAND GROWTH AND YIELD TABLES

There were several steps involved in building the growth and yield tables for the Forest. The first step was to stratify stand polygon data from the Forest's CISC database using groupings of forest types (Table B - 1), stand age, and productivity class to determine what tables would be the most useful. Since detailed stand inventory data is not available within the CISC database, the second step was to find plot data that could be correlated with the attributes available in CISC.

Under the authority of several acts including the McSweeny-McNary Forest Research Act of 1928, the Forest Service conducts periodic forest inventories of all states including Kentucky. The Forest Inventory and Analysis (FIA) program has the responsibility to collect, maintain, and provide required analysis of this data. Sample plot data collected by the FIA includes individual tree information such as tree height, diameter, and species. Each plot is assigned a forest type, age, and other site information that happens to correlate well with the Forest's CISC stand polygon data. However, before FIA data could be used, a reasonable sample area and number of plots had to be selected for each stratum. Once the plots were selected and stratified, using the same groupings described above for the CISC stand data, a set of statistics such as the coefficient of variation was computed for each data set. This analysis was accomplished through the use of the PreSuppose computer program.

PreSuppose

Pre-Suppose is a program developed by the Forest Management Service Center (FMSC)[4] to query and sort Forest Inventory and Analysis (FIA) data. The FIA data was first reformatted by the FMSC to be compatible with PreSuppose. As the data is sorted, the program prepares a "locations" file and a "stand list" file needed for the next step of analysis (the Suppose program).

The original thought was to use just plots from National Forest for both Cumberland Plateau and Mountains; however, a sufficient sample was not available, so plots on private lands were used as well. On examination, plots from private and National Forest lands usually had very similar diameter and volume characteristics for the same forest type, age and site class.

Forest Inventory & Analysis (FIA) data that was converted to an FVS-ready format was downloaded, extracted, & setup for Kentucky & Tennessee (Cumberland Mountains & Plateau). The 5th survey Virginia (northern Piedmont) data was also downloaded, extracted, and setup later on as it became evident that Kentucky or Tennessee data was lacking in some stratifications.

Suppose

Suppose[5] is the graphical user interface (GUI) for the Forest Vegetation Simulator (FVS). *Suppose* permits proposed management plans or policies to be entered into the FVS system, using methods more directly related to forest management than directly using the FVS input system (keywords). The program provides tools allowing use of FVS without knowing the FVS keyword language or remembering the details of keyword usage. *Suppose* also provides an evaluation platform that can be used to gather user feedback for the designers of the system.

Suppose simulates changes in forest vegetation over a long time span (100-400 years) for a stand or group of selected stands. The program can process from 1 to about 1,000 forest stands. *Suppose* accomplishes the simulation by creating an input file used by the Forest Vegetation Simulator (FVS) and by then starting the appropriate FVS program that reads and processes the input file. The program contains the desired geographic variant and extensions to the base FVS system. However, FVS, not *Suppose*, actually accomplishes the simulation.

The output from *Suppose* is a simulation file interpreted by FVS as a keyword file. This file is read by FVS, along with the tree-level inventory data, for FVS to make the projection.

[4] Forest Management Service Center (FMSC), a sub-unit of the Forest Service's Washington office, located at Fort Collins, CO.

[5] *Suppose* was developed by Nicholas L. Crookston, of the Rocky Mountain Research Station's Forestry Sciences Laboratory <http://forest.moscowfsl.wsu.edu/>.

Forest Vegetation Simulator (FVS) Model

The primary tool used for building time-based yield tables, which are then used in the Spectrum model, is the Forest Vegetation Simulator model (FVS). FVS is an individual-tree, distance-independent, growth and yield model. It is based on the Stand Prognosis Model[6] The team at the USFS Forest Management Service Center in Fort Collins has now calibrated sixteen additional variants of the model to specific geographic areas throughout most regions of the United States.

FVS allows the user to calculate estimates of forest stand structure and species composition over time and quantify this information to (1) describe current and future forest stand conditions, (2) simplify complex concepts of forest vegetation into user-defined indices, attributes, etc., and (3) allow the manager to ask better questions about growth and yield of forest stands and complete analyses to answer those questions.

The FVS model structure contains modules for growing trees; predicting mortality; establishing regeneration; simulating growth reductions, damage, and mortality due to insects and disease; performing management activities; calculating tree volumes; and producing reports. One of the strengths of the FVS system is its ability to incorporate local growth rate data directly into the simulation results.

Growth rates for common species on FIA plots were compared to growth rates generated by FVS. Also, volume information from past timber sales on the DBNF was compared to yields generated by FVS. The information obtained from these comparisons was used to calibrate FVS.

For mature to advanced stand ages, FVS tended to under-predict mortality and over-predict growth for most forest/community types. To correct this tendency, growth coefficients were decreased and mortality coefficients were increased for most species at ages 65 and above, and then again for ages 100 and above.

Yields were developed for each analysis area under scenarios for different regeneration harvest methods and for thinned and un-thinned conditions. FVS reported projected yields for each product class at 10-year intervals. These yields were then used to build the yield tables for the Spectrum model.

SPECTRUM – COSTS AND REVENUES OF MANAGEMENT ACTIONS

The associated costs of activities such as stand regeneration, stand improvement and timber harvesting used in the Spectrum model to create various vegetative conditions are summarized in Table B - 9. Such activities may occur only when certain conditions are met. These conditions are displayed in the table. Regeneration and other silvicultural costs were estimated from historic records such as KV plans; a regional logging engineer estimated cable-logging costs; and the Forest transportation planner estimated road costs, based on an average timber road (service level D, maintenance level 1). Revenues of the timber program are based on the stumpage prices received by the Forest from 1990 to 1995, which are shown in Table B - 10. All costs and revenues were adjusted to 2000 dollars, based on the Gross National Price Deflator. A four percent discount rate was assumed within Spectrum.

[6] The Prognosis Model developed by Albert Stage at the Intermountain Research Station.

Table B - 9. Spectrum Analysis – Costs of management actions, and conditions where applied

	Conditions where applied		Costs				
Management Action	**Level identifier-code[1]**	**Age of Stand at Which Action is Initiated**	**Sale Preparation and Administration cost/ mcf[2]**	**Regeneration cost/acre**	**Additional Logging Cost per mcf for areas with >40% slope**	**Road Construction (areas >1/4 mile from roads) cost/acre**	**Savannah/ Woodland burning costs/acre**
Create Canebrakes	6-Riparian	Any age less than 20	$280	$240			N/A
Create Hardwood wooded grassland	3-HDWD[3], 6-none	Age 60 and up			$170	$190	$40 (3 times during the first decade, 2 times during all others)
Harvest to residual 15 BA	6-none	100 years plus	$280	Pine - $410 Others- $140	$170	$190	
First thinning to 40 BA residual	4-less than 70; 6-none	Thin at 80; Do not harvest	$280	Pine - $410 Others- $140	$170	$190	$40 (3 times during the first decade, 2 times during all others)
Second thinning 40 BA residual	6-none	Thin at 140	$280	Pine - $410 Others- $140	$170	$190	$40 (3 times during the first decade, 2 times during all others)
First thinning to 60 BA residual	6-none	Thin at 80	$280	Pine - $410 Others- $140	$170	$190	
Second thinning to 60 BA residual	6-none	Thin at 140	$280	Pine - $410 Others- $140	$170	$190	
Pine savannah	6-none, 3-pine lands	70 to 140	$280	Pine - $410 Others- $140	$170	$190	$40 (3 times during the first decade, 2 times during all others)
Shrub-sapling openings	6-none	Any age less than 20	$280	$140 each decade	$170	$190	
No active management	Available to all Analysis Units		No direct costs applied				

[1] See Tables B-4, B-5 and B-7 for a summary of codes used.

[2] Thousand cubic feet

[3] Hardwood

Table B - 10. Timber stumpage prices used in the Spectrum analysis

	Appraisal Group					
Group Name	Top Value Hardwood	High Value Hardwood	Mid Value Hardwood	Mid Value Pine	Low Value Hardwoods	Pulpwood-size
Code	TVH	HVH	MVH	MVP	LVH	PTS
Example Species	Red Oak, Cherry	White Oak	Tuliptree, Basswood	Pine	Scarlet Oak	(Hardwood & Pine)
Price / CCF	$125	$97	$42	$40	$16	$5

SPECTRUM – BENCHMARK RUNS

As a part of the Analysis of the Management Situation, benchmark runs are required to be run to define the range within which alternatives can be constructed (CFR219 (e)(1)). The "Current Management" benchmark required by CFR219.12 (e)(2) is Alternative A, which is displayed in Table B - 13. Three benchmark runs were made to show how much the forest could produce of a single objective without being constrained by other objectives (Table B - 11). These three runs were:

- Maximize net present value without a non-declining yield (NDY) constraint.
- Maximize net present value (NPV) with non-declining yield constraint in place.
- Maximize allowable sale quantity (ASQ) with non-declining yield constraint in place.

The Minimum Level Benchmark is "the minimum level of management which would be needed to maintain and protect the unit as part of the National Forest System together with associated costs and benefits" (36 CFR 219.12(e)(1)(i)). This benchmark is the same as alternative B, which is described in chapter two under the heading of Alternatives Considered but Eliminated.

Table B - 11. Spectrum Benchmark Runs, by NPV, ASQ, and LTSY

Benchmark Run	NPV ($ 1998)	ASQ (mcf/decade)	LTSY (mcf/year)
Maximize NPV without NDY	$23,717,747	N/A	2,698
Maximize NPV with NDY	$23,429,532	50,817	5,082
Maximize ASQ with NDY	$6,937,847	53,175	5,318
Minimum Level	$0	0	0

NPV=net present value, ASQ=allowable sale quantity, LTSY=long-term sustained yield, NDY=non-declining yield

Table B - 12. Spectrum Benchmark Runs, harvest per decade (thousand cubic feet)

	Decade											
Benchmark Run	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11-14**	**15**
Maximize NPV with non-declining yield	50,817	50,817	50,817	50,817	50,817	50,817	50,817	50,817	50,817	50,817	~	50,817
Maximize NPV without non-declining yield	58,422	35,796	57,005	61,840	65,157	0	0	0	21	7,251	~	7,675
Maximize ASQ with non-declining yield	53,176	53,176	53,176	53,176	53176	53,176	53,176	53,176	53,176	53,176	~	53,176
Minimum Level	0	0	0	0	0	0	0	0	0	0	0	0

SPECTRUM – ALTERNATIVE RUNS

Each of the six alternatives was analyzed using the Spectrum modeling system. Each alternative had a specific set of objectives. All alternatives had a non-declining yield constraint applied over a 150-year planning horizon. All alternatives had a maximum budget constraint based on 110% of existing budget. The new riparian prescription was applied to all alternatives except Alternative A. Each alternative had a specific level of southern yellow pine restoration. To set this level for each alternative, the maximum amount of pine restoration subject to the different alternative constraints was estimated. Once determined, the alternative specific level of pine restoration was then set as a constraint. A multiple goal objective function was used. Instead of maximizing a certain objective, acre objective goals were set with a priority levels assigned to each goal.

Alternative A was formulated to mimic a schedule of management activities that most likely would be applied if the current plan were applied without change. With the existing plan emphasis on the red-cockaded woodpecker habitat management, the main objective of Alternative A was southern yellow pine restoration. In areas that were almost completely deforested by the southern pine beetle infestation, the minimum number of acres reforested in southern yellow pine the first decade was 20,000 acres. There were no uneven age, savannah, or woodland management areas in the current plan and therefore there were none in Alternative A. Harvest entries were designed to approximate 70-120 year rotations as directed in Amendments 6 and 8 of the Plan. In order to create these rotation ages, 6088 acres of pine were scheduled for harvest each decade following the 10th decade and 7520 acres following the 13th decade. The first priority was harvest acre goals for the different stand types (pine oak, mesic and xeric oak, mixed mesophytic and white pine). Thinning levels in the four management areas were the second priority goals in Alternative A.

Alternative B-1 was formulated to represent a schedule having a minimum amount of vegetation management based on minimum needs for viability of plant and animal species. The number of southern yellow pine restoration acres was maximized subject to a limit of 4,633 acres each of the first 8 decades with no pine restoration occurring after the 8th decade. The first priority in Alternative B included a harvest level between 7,000 and 7,700 acres each decade and the minimum amount of uneven age and shrub-sapling openings required. The second priority included various thinning levels in the four management areas and the creation of a minimum level of pine and hardwood woodland and canebrake management area acres. The last priority was the creation of a minimum number of pine and hardwood savannah management areas.

Alternatives C, C-1, & D were formulated to best meet species viability and biodiversity goals along with various levels of recreation. These desires were simulated in Spectrum by varying the maximum budget amounts available for vegetation management. An assumption was made that with a total forest budget cap for all alternatives, as recreation funding increases from Alternative C, C1, to D respectively, vegetation management funding would decrease. The constraint for the minimum level of southern yellow pine restoration was 8,000 acres in the first three decades. There was also a constraint eliminating from harvest for the entire planning horizon all stands that are currently older than 120 years of age. The first priority included a harvest level between 16,875 and 20,625 acres each decade of the planning horizon, and a certain amount of shrub-sapling opening and uneven age management areas. The second and third priority levels included the same management actions as Alternative B1 with higher acreage goals for each management action.

Alternative E-1 was formulated to allow a high level of timber products output, while incorporating the new riparian management strategy. Goals and constraints were set to simulate an approximate rotation length of 100 years for all species. The minimum viability requirements were the same as those used in Alternative B1. The first priority in Alternative E1 was a harvest level between 36,364 and 44,000 acres each decade.

The following Table B - 13 displays some important results from alternative runs. More detailed information is displayed in Chapter 3 – Analysis of Alternatives, Timber Products.

Table B - 13. Spectrum Analysis Results - Allowable sale quantity (ASQ), long-term sustained yield (LTSY), and net present value (NPV) by Alternative

	Alternatives					
	A	**B-1**	**C**	**C-1**	**D**	**E-1**
ASQ for first decade (MCF[1])	40,899	5,072	21,665	21,924	21,504	44,851
LTSY (MCF/ year)	5,300	1,176	3,976	3,973	3,915	5,700
Decade LTSY achieved	4th	13th	8th	8th	9th	15th
NPV	$10,830,668	-$3,546,403	-$3,588,943	-$3,468,237	-$3,275,232	$12,018,682

[1] MCF = thousand cubic feet

FOREST TYPE GROUPINGS

Table B - 14. Grouping of Forest Type* by Community Type and Analysis Source

Community Type	Old-Growth Analysis	Viability Analysis	Spectrum Analysis
Conifer/N. Hdwd.	3,4,5,8,9,10	8,9,10,42	
W. Pine/Hemlock		3,4,5	3,4,5,8,9,10
Mixed Mesophytic	41,50,56,81	41,50,56,81	
Mixed Mesophytic/Floodplain			41,50,56,58,61,71,72,74,75,81,82,88
River Floodplain Hdwd.	46,58,71,72,75	Riparian Assoc.	
Eastern River Front	74,82	Riparian Assoc.	
Dry-Mesic Oak	42,51,52,53,54,55	51,53,54,55	
Xeric-Mesic Oak			42,43,51,52,53,54,55,59,60
Dry-Xeric Oak	43,52,59,60	52,59,60	
Dry-Xeric Cedar Oak		11,35,43	
Mixed Oak/Yellow Pine			44,45,46,47,48
Dry-Mesic Oak-Pine	31,44,45,47,48		
Dry-Xeric Mixed Pine & Oak		16,45	
Dry-Mesic Mixed Pine & Oak		12,13,15,44,46,47,48	
(Xeric)Pine & Pine-Oak	12,13,15,16,20,32,33,38		11,12,13,15,16,17,31,32,33,35,38
Yellow Pine		31,32,33,38	

*Table B - 15. Forest Type Codes used on the Daniel Boone National Forest

CISC Code	CISC Forest Type	CISC Code	CISC Forest Type
03	White Pine	50	Yellow-poplar
04	White Pine-Hemlock	51	Post Oak- Black Oak
05	Hemlock	52	Chestnut Oak
08	Hemlock-Hardwood	53	White Oak- Northern Red Oak- Hickory
09	White Pine-Cove Hardwood	54	White Oak
10	White Pine-Upland Hardwood	55	Northern Red Oak
11	Eastern Redcedar-Hardwood	56	Yellow-Poplar/ White Oak/ Northern Red Oak
12	Shortleaf Pine-Oak	57	Scrub Oak
13	Loblolly Pine-Hardwood	58	Sweetgum- Yellow-poplar
15	Pitch Pine-Oak	59	Scarlet Oak
16	Virginia Pine-Oak	60	Chestnut Oak- Scarlet Oak
31	Loblolly Pine	63	Sugarberry-American Elm-Green Ash
32	Shortleaf Pine	70	Black Cherry
33	Virginia Pine	71	Black Ash-American Elm-Red Maple
35	Eastern Redcedar	72	River Birch-Sycamore
38	Pitch Pine	73	Cottonwood
41	Cove Hardwoods-White Pine-Hemlock	74	Willow
42	Upland Hardwoods-White Pine	75	Sycamore-Pecan-American Elm
43	Oak-Eastern Redcedar	76	Silver Maple-American Elm
44	Southern Red Oak-Yellow Pine	81	Sugar Maple-Beech-Yellow Birch
45	Chestnut Oak-Scarlet Oak-Yellow Pine	82	Black Walnut
46	Bottomland Hardwood-Yellow Pine	83	Black Birch
47	White Oak-Black Oak-Yellow Pine	88	Black Locust
48	Northern Red Oak- Hickory- Yellow Pine		

SELECTION OF MANAGEMENT INDICATOR SPECIES (MIS)

National Forest Management Act (NFMA) regulations adopted in 1982 require selection of management indicator species (MIS) during development of forest plans (36 CFR 219.19(a)). Reasons for their selection must be stated, and this document describes the process and rationale used to select MIS for the DBNF's 2004 Land and Resource Management Plan. Monitoring of MIS populations must be feasible as well meaningful and comply with relevant statutes, regulation, and case law, including recent court rulings.

Management indicator species (MIS) are to be selected "because their population changes are believed to indicate the effects of management activities" (36 CFR 219 (a)(1)). They are to be used during planning to help compare the likely effects of alternatives (36 CFR 219.19(a)(2)), and as a focus for monitoring (36 CFR 219.19(a)(6)). Where appropriate, MIS are to represent the following types of species (36 CFR 219 (a)(1)):

a) Threatened and endangered species on state and federal lists
b) Species with special habitat needs
c) Species commonly hunted, fished, or trapped
d) Non-game species of special interest
e) Species selected to indicate effects on other species of selected major biological communities.

Since adoption of MIS regulations, the scientific community has critiqued and refined the management indicator species concept (Caro and O'Doherty 1999, Simberloff 1998, Noss 1990, Landres et al. 1988, and Weaver 1995). These analyses have identified more appropriate uses as well as some limitations of the MIS concept. Critical reviews generally caution against overreaching in the use of indicator species, especially when making inferences about ecological conditions or the status of other species within a community. Caution is advised because diverse factors affect populations of each species within a community, and each species' ecological niche within a community is unique.

To reflect this current scientific understanding while meeting the letter and spirit of regulations, the DBNF has made great effort to clearly define the legitimate uses and limitations of each MIS. The MIS model is but one tool for developing management strategies and monitoring programs that fulfill NFMA requirements to promote diversity of plant and animal communities. Other means used in comprehensive planning for plant and animal diversity include:

a) Management objectives and standards for maintenance and restoration of desired ecological conditions based on knowledge of overall ecosystem structure and function
b) Biological evaluations and assessments at both the forest plan and site-specific project levels
c) Evaluations of risk to species of viability concern at the forest plan level.

Additional elements useful for monitoring the effects of plan implementation on plant and animal diversity include, where appropriate, the monitoring of:

a) Key ecological conditions
b) Levels of management activities important to restoration and maintenance of community diversity

c) Species assemblages (birds, bats, fish, etc.)
d) Harvest levels of game and other demand species
e) Populations and/or habitats of threatened, endangered, and sensitive species.

MIS SELECTION

Consideration of MIS for the 2004 Forest Plan started with the current list of MIS (Table 1) and the most recent results of population monitoring and evaluation (USDA Forest Service 2001b). The planning staff also reviewed region-wide lists of MIS identifying opportunities for use of common MIS for common purposes. Additional species were considered under each of the five categories of potential MIS identified in 36 CFR 219.19(a)(1). All species considered were assessed using the following criteria to determine their appropriateness as MIS:

a) Changes in the species' population should primarily reflect the effects of national forest management activities
b) Population trends of the species must be capable of being effectively and efficiently monitored and evaluated.

Table 1. Management Indicator Species selected for use in the DBNF's 1985 Forest Plan and primary reason(s) for their original selection.

Common Name	Scientific Name	Primary reason(s) for original selection
White-tailed Deer	Odocoileus virginianus	Ecological indicator; Game species
Eastern Bluebird	Sialia sialis	Ecological indicator
Rufus-sided (Eastern) Towhee	Piplio erythrophthalmus	Ecological indicator
Eastern Gray Squirrel	Sciurus carolinensis	Ecological indicator; Special needs; Game species
Red-cockaded Woodpecker	Picoides borealis	Ecological indicator; Special needs; T&E species
Pileated Woodpecker	Dryocopus pileatus	Ecological indicator; Special needs
Blackside Dace	Phoxinus cumberlandensis	Ecological indicator; T&E species
Arrow Darter	Etheostoma sagitta	Ecological indicator
Fantail Darter	Etheostoma flabellare	Ecological indicator
Rainbow Darter	Etheostoma caeruleum	Ecological indicator
Brindled Madtom	Noturus miurus	Ecological indicator
Stone Roller	Campostoma anomalum	Ecological indicator
Smallmouth Bass	Micrpterus dolomieu	Ecological indicator; Games species

Before examining the suitability of individual species as MIS, some general observations about some species groups can be made.

Migratory Birds: Many migratory bird species often serve as MIS during the first round of forest plan development. They have been retained and even highlighted as MIS in some recent plan revisions and amendments in the Southern Region. Their retention or prominence as MIS has been based on the following characteristics:

a) Many are very specific in their habitat relationships, being tied very closely to specific vegetation composition or structure
b) Many are common and widespread in suitable habitats, facilitating monitoring of population responses
c) They can be monitored relatively effectively using standardized protocols currently in use on all national forests, and
d) Relatively good information is available on regional and range-wide population trends, which can be used to put national forest data into context.

Their migratory habits, however, lead these species to spend a significant portion of their lives off of national forest land where they may be subject to many other factors that may affect their population trends.

Consideration of migratory birds for MIS selection, therefore, must include a balanced view of these positive and negative characteristics. Where other species are available and more appropriate for meeting the identified purpose, they should be selected over migratory birds. Where migratory birds are the best species available, they may be selected if limitations to, and strategies for, population monitoring and evaluation are clearly considered.

There are opportunities to isolate the effects of national forest management from other effects by comparing trends occurring on national forest system land with those occurring on a broader scale. Stable or increasing trends observed on national forests while broader trends are decreasing would indicate positive effects of national forest management, and vice versa. Similar trends documented at national forest and broader scales, regardless of their direction, would suggest broader scale factors are prevalent. Additional limitations on monitoring bird trends have been previously documented (Gaines and Morris 1996, Linder and Buehler 2002).

At current levels of funding, it is not feasible to monitor enough bird points to document trends at an individual national forest scale with high levels of statistical precision. Current strategies are designed to document trends across national forests at ecoregional scales. While not ideal, this approach will still allow assessment of national forest management effects, especially where such management is similar across forests within an ecoregion, as is the case in the Southern Appalachians and the Piedmont. In addition, other methods of analyzing data, such as looking at habitat associations and frequency of occurrence within indicated habitats, can shed light on a species' response to management actions on a more local scale. DBNF planners believe this meets the intent of regulations that MIS be used to indicate the effects of management on wildlife resources.

Herps: Most amphibians and reptiles do not meet the criteria of appropriate MIS because they often require a sampling effort beyond the DBNF's current capability. Amphibians can be particularly difficult to monitor due to the high sampling variability (Hyde and Simons 2001). The inability to count them with precision makes inferences on relationships between population trends and habitat changes difficult and unreliable. The Forest Service is working closely with cooperators to improve, develop, and standardize survey protocols for both amphibians and reptiles so that effective monitoring programs can be established and expanded. However, at this point, inherent limitations to monitoring this group make them generally ineffective as MIS.

Plants: Plants can serve as effective indicators of specific habitats and conditions. Many are well documented for their responsiveness to forest management activities, both positive and negative. Species that are fire-dependent, or highly associated with specific successional stages, can be particularly effective as MIS. Plants are often capable of being effectively monitored due to their immobility. The monitoring precision necessary varies with purpose of the MIS selection, but in many cases high precision is not needed to show population response to management activities. Additionally, while many plants often appear to be good indicators of specific conditions, they do not always occur where expected, an indication that other unknown factors may be at work. However, monitoring of overall plant community composition often provides better information on management effects than focusing on one or just a few species.

Terrestrial Invertebrates: Terrestrial invertebrates are generally deemed inappropriate as MIS because monitoring protocols are not well developed for most species, and little is known of their habitat relationships. Their populations also tend to fluctuate widely due to unknown factors.

The remainder of this section documents consideration of the appropriateness of species as MIS by category as listed at 36 CFR 219 (a)(1).

THREATENED AND ENDANGERED SPECIES

Species within this category are identified as threatened or endangered on state or federal lists. They are selected to focus attention on species with viability concerns whose population levels are directly tied to effects of national forest management. These species already receive attention during planning and monitoring by virtue of their status under the Endangered Species Act, Forest Service sensitive species policy, and NFMA viability regulations. Therefore, designation of species from this category for coverage by MIS requirements is in many ways redundant. Our consideration of MIS status for species within this category was focused on identifying those species whose population trends and continued existence are especially dependent on national forest management activities.

Bats: The most high-profile bat species in this category are the Indiana bat (*Myotis sodalis*), gray bat (*Myotis grisescens*), and Virginia big-eared bat (*Corynorhinus townsendii virginianus*). Populations of these species benefit from national forest management, which provides protection of caves used for roosting and hibernation. Bat population monitoring within these caves is currently conducted. However, because bat populations disperse widely (beyond national forest boundaries) during non-hibernation seasons, little is known about their movements or the factors limiting populations. Changes in populations documented through cave counts reflect all of these other factors, some of which are not necessarily associated with national forest management. In addition, other than cave counts, monitoring of bat population trends is not feasible due to technical limitations in sampling free-ranging bats. For these reasons, bats are deemed inappropriate as MIS. They will, however, continue to be addressed when environmental effects are documented at both the forest plan and site-specific project levels. Cave counts and forest-wide inventory efforts will also continue.

Bald Eagle (*Haliaeetus leucocephalus*): One nesting pair as well as transient individuals occurs on the Forest. The species is ineffective as an MIS because one pair is too small of a population sample. The wide ranging movements and the transient nature of other individuals using the national forest also offers insufficient information. Because bald eagles spend much of their time off the national forest, it would be difficult to associate population trends with national forest management activities. Monitoring of bald eagles as a T&E species, however, will continue.

Red-cockaded Woodpecker (*Picoides borealis*): The RCW would perhaps be our most appropriate T&E species to be selected as an MIS. It is highly responsive to habitat changes induced through active forest management, and it is easily and effectively monitored using long-established and consistent protocols. However, it was not chosen as an MIS because the DBNF (and presumably Kentucky) population was extirpated following a severe southern pine beetle epidemic in 1999-2002 that killed most yellow pine stands on the Forest.

White-haired goldenrod (Solidago albopilosa): White-haired goldenrod, which does not appear to have biological or habitat barriers to survival, is a species for which protection of populations is important. Management of these populations per se may not be needed, however, and a direct tie between management and species response is unclear. The species is currently monitored and will be monitored in the future.

T&E and Other Rare Salamanders: As discussed previously, these species are generally not effective MIS due to their high population variability, the influence of moisture on their detectability, and the difficulty in relating population changes to management effects. Efforts to monitor T&E and other rare salamanders will continue or be expanded as effective techniques are validated. However, designating them as MIS is inappropriate at present.

T&E and Other Rare Fish: Stream and riverine fish are deemed inappropriate as MIS because sampling variability is high, making determination of trends difficult (see USDA Forest Service 2001b). In addition, their sensitivity to habitat changes arising from off-forest influences, as well as their ability to move between private and national forest lands in many cases, makes it difficult to attribute population changes to national forest management. However, monitoring of T&E and other rare fish species will continue as part of a comprehensive stream-monitoring program.

Mussels: Mussels are also deemed inappropriate as MIS because of the difficulty inherent in monitoring trends and attributing population changes to management activities on national forests. Mussels are greatly dependent on high-quality water, which is influenced by the cumulative effects of activities originating on private as well as national forest lands. However, as with other T&E species, inventory and monitoring of mussels will continue.

Rare Plants: Many T&E plants require protection only of known locations. Because their populations do not primarily reflect effects of management activities, they are often ineffective as MIS. However, T&E plant species that are known to be highly associated with, or responsive to, forest management activities are appropriate. Fire-dependent species meet these criteria. One T&E species on the forest that probably is dependent on prescribed fire is American Chaffseed (*Schwalbea americana*). This species is currently considered historic on the Forest, but there are no populations with which to monitor the effects of management on its recovery. Therefore, it has not been selected as an MIS. Other T&E plant species will continue to be monitored.

SPECIES WITH SPECIAL HABITAT NEEDS

Species under this group are closely dependent on special habitat elements that may be affected by national forest management. They are considered for selection because they may help document the effects of management on these special habitat elements.

Snag dependents: The pileated woodpecker (*Dryocopus pileatus*) was considered for selection as an MIS because it requires large snags for nesting and feeding. The occurrence of this species may be correlated with forested habitats containing abundant large dead trees and fallen logs (Hamel 1992). Such habitat may also be used by other woodpeckers, owls, numerous other birds, mammals, and amphibians. Use of the pileated woodpecker could help indicate the effects of management activities on the availability of forests with a desired abundance of snags. However, according to local observations and bird survey data, this species is highly sensitive to human presence. It may leave an area, such as a monitoring station, before an observer can account for it. Its use as an indicator is also limited by its wide-ranging habits, which cause it to be documented in forest types that are not particularly suitable. It also occurs at relatively low densities, reducing the number of data points available for trend estimates. For a variety of reasons, plan provisions call for snag retention as well as creation. As vegetation surveys associated with bird surveys, and project planning collect snag data, analysis of this variable will provide some picture of management effects on the pileated woodpecker and other snag-dependent wildlife.

Hard mast dependents: Although the gray squirrel (*Sciurus carolinensis*) is the species most closely associated with hard mast capability, it is an ineffective indicator of the quality or abundance of these habitats. Even in good habitats, its populations can fluctuate greatly as weather conditions create wide variations in mast production from year to year (see USDA Forest Service 2001b). Other species such as bear, deer, and turkey benefit from hard mast production, but their population trends also reflect a variety of other factors, including hunting harvest. Acres of mature oak forest is a more useful and direct indicator of trends in hard mast production capability and, therefore, will be used to indicate effects to mast-dependent species instead of an MIS.

Mature forest interior dependents: Concern over forest interior habitats is primarily focused on effects to migratory birds. Several bird species are associated with forest interior. The ovenbird (*Seiurus aurocapillus*) is deemed the most appropriate of these as an MIS. It is strongly associated with mature forest interior habitats (Hamel 1992, Crawford et al. 1981) and is also common enough to be feasibly monitored for trends. Long-term monitoring of this species has resulted in some of the most robust data sets of any of the interior bird species surveyed on the Forest. This species is selected to help indicate the effects of management on the availability of suitable mature forest interior habitats. Other elements, such as landscape analysis of forest fragmentation using remote sensing data, would supplement information received from monitoring this species. In addition we have selected the black-throated green warbler specifically as a resident of mature cove forest. Our monitoring data indicate it is a good choice with much the same qualities as ovenbird.

High-elevation early-successional dependents: The Forest currently has no high-elevation habitat, although Forest Plan objectives encourage the acquisition of such. We have a few recent records of golden-wing warbler on the Forest, but at lower elevations (1200-1300 feet amsl). The golden-winged warbler (*Vermivora chrysoptera*) would be the most appropriate MIS for high-elevation early-successional habitats because of its strong association with these habitats and because its populations should be responsive to forest management efforts to create and sustain such habitats. But it was not chosen as an MIS because the DBNF contains little of its usual habitat, and there is only scattered evidence of the species on the Forest. The DBNF will monitor the species, however, as part of the Forest Service's Region 8 Landbird monitoring program.

Mature riparian forest: The Acadian flycatcher (*Empidonax virescens*) is deemed the most appropriate species to indicate management-induced changes to mature riparian forests. It is highly associated with mature deciduous forests along streams and bottomland hardwoods, which it uses for feeding and reproduction (Hamel 1992). It can be effectively monitored using proven, consistent protocols. It is relatively common in these habitats, providing enough data for evaluation. This species is selected to help indicate the effects of management activities on mature riparian habitats. Salamander species, although often associated with this habitat, are not particularly effective MIS for the reasons described previously.

Cliff-top Pitch Pine: Pitch pine (*Pinus rigida*) was severely impacted by the recent southern pine beetle epidemic. It was in low numbers prior to this epidemic and during it, most mature or mid-age individuals died and much of the limited natural regeneration that had occurred also died. Pitch pine regeneration, both natural and artificial, will be monitored to assess gains in restoration of the species and the habitat it helped produce along cliff tops.

SPECIES THAT ARE HUNTED, TRAPPED, AND FISHED

Species considered under this category include deer, turkey, quail, fish, and other harvestable species that are in high public demand for consumptive uses. Demand MIS are used to help assess effects of management on meeting this expectation of national forests. Drawing inferences about the effect of national forest management on these species is difficult, in large part, because the state fish and wildlife harvest regulations control their populations. Nevertheless, species in this group may be appropriate as MIS if the role of harvest regulation and demand can be evaluated along with habitat trends. This situation will normally occur where state fish and wildlife agencies collaborate in monitoring efforts.

Furbearers: Common species of furbearers found on national forests are fox, bobcat, raccoon, mink, otter, and beaver. As a group, these species were judged inappropriate for selection as MIS for several reasons. Consumptive demand for furbearers on the DBNF is small. These species are typically habitat generalists, making evaluation of relationships to habitat changes difficult. In addition, they generally are wary, often occur at low densities, and, therefore, are not feasible to monitor with precision.

Eastern wild turkey (*Meleagris gallopavo*): This species is distributed across the Forest and in good numbers. However, as a generalist that uses a wide variety of habitats, the species may or may not be affected by Forest Service management. The species is most commonly encountered when it ventures into grassy openings, and monitoring of such occurrences may not reflect populations. Wild turkey is also affected by mast production, which is erratic and weather related (see USDA Forest Service 2001b). Eastern wild turkey will be monitored through state harvest records and the Forest's participation in the Region 8 Landbird monitoring program.

Ruffed grouse (*Bonasa umbellus*): This species is distributed across the Forest in moderate numbers, and can be expected to respond to Forest Service management practices. Specific, intense management for this species occurs in some areas of the Forest skewing populations, however, and the state periodically captures animals from the Forest for re-introduction elsewhere, again skewing populations. While this species is not selected as an MIS, it will be monitored through state harvest records and the Forest's participation in the Region 8 Landbird monitoring program.

Eastern gray squirrel (*Sciurus carolinensis*): This species is distributed across the Forest in moderate numbers. It was not chosen as an MIS for the reasons stated above under mast-dependent species.

Black bear (*Ursus americanus*): This species is slowly spreading into Kentucky. Its numbers are low and consist primarily of displaced young males. It is a generalist and uses a wide variety of habitats that may or may not be affected by Forest management. In addition, the Black bear was not considered as a management indicator species because recent research (Mitchell and Powell 2003) indicates their response to managements actions differ according to maturity and sex. The level of monitoring required to differentiate among age/sex/management action relationships is beyond our means.

North American elk (*Cervus canadensis*): This species was recently re-introduced into Kentucky to establish a population not seen in the state for more than 200 years. Because of this recent arrival (via re-introduction) in Kentucky and its limited distribution on the DBNF, this species was not chosen as an MIS. The Kentucky Department of Fish and Wildlife Resources continues to fund research and monitoring projects to learn more about the lifestyle of elk in Kentucky.

Northern bobwhite [quail] (*Colinus virginianus*): This species is present on the Forest in low, but increasing, numbers. It is expected to respond to Forest management action in appropriate habitat types. It is associated with a desired mix of grassland, wooded grassland/shrubland, woodland, and open forest maintained by fire in which grasses and forbs dominate the vegetation on the forest floor. This species has been chosen as an MIS.

White-tailed deer (*Odocoileus virginianus*): This species is widespread on the Forest in moderate to high numbers. Review of available data (USDA Forest Service 2001b) indicated that it is a poor ecological indicator, in part because of its generalist nature. Forest management may or may not affect population numbers. It was chosen as an MIS specifically because of interest shown by the state and other groups in this species' high profile game status. Various habitat conditions on the Forest will be monitored which may be related to population trend data collected by the state.

NON-GAME SPECIES OF SPECIAL INTEREST

Species considered under this category are those for which there exists special public interest for non-consumptive reasons. They may be selected for the purpose of focusing assessment on such species when management is expected to have a major influence on their populations. Public interest in non-game species is typically generalized, rather than focused on one or a few species (e.g., interest in wildflowers, birds, and other wildlife for viewing or nature study). Most species of special interest are represented by other species already chosen in other categories. Interest in any one species is not sufficient to drive MIS selection beyond those species already selected under other categories. Those species cover the special interests that are to be considered under this category.

SPECIES THAT INDICATE EFFECTS TO MAJOR BIOLOGICAL COMMUNITIES

Species considered under this category are those whose populations respond to management-induced changes in key ecological conditions within a community. These ecological conditions should be important to other members of the community as well. Selection of MIS under this category should help focus attention on maintenance and restoration of desired conditions within major biological communities.

Rare Communities: By definition, rare communities are small and discrete habitats that are uncommon on the landscape. Because of their rarity and importance to providing for a diversity of plant and animal communities, occurrences will be monitored directly. Monitoring will focus on the maintenance of desired conditions including presence of associated species. Because monitoring will be done directly, no MIS are selected for these communities.

Mid- and Late-Succesional Mesic Deciduous Forest: The cerulean warbler (*Dendroica cerulea*) is selected as the MIS for mid- to late-successional mesic deciduous forests. Breeding territories are especially associated with canopy gaps within these forests. Although it is relatively common on the DBNF, as least in some areas, monitoring will focus on determining presence and population response to creation of canopy gaps through management activity. This species is selected to help indicate effects of canopy gap creation on species associated with mid- to late-successional mesic deciduous forests. In addition, the black-throated green warbler (*Dendroica virens*) was selected as an MIS in this forest type for the reasons stated above in mature forest dependents.

Mid- and Late-Successional Hemlock-White Pine Forests: Native communities of this type are primarily located along streams and stream terraces. Management direction is to protect these forests, but little active management is planned. Therefore, no MIS is selected for this community.

Mid- and Late-Successional Oak and Oak-Pine Forests: Because of their wide distribution across moisture gradients, mid- and late-successional oak and oak-pine forests support a wide variety of species. Cerulean warbler, selected as an MIS for mid- and late-successional mesic deciduous forests adequately, represent, in part, mesic oak forest communities. This species is expected to respond positively to management actions (including thinning and moderate frequency burning) designed to stimulate advanced oak regeneration and perpetuation of the forest type on these mesic sites. Drier oak forests support a slightly different mix of species due to their more open condition. [To represent this upland oak and oak-pine community, the summer tanager, in part, is selected as an MIS. This species is most abundant in a mix of open upland mature deciduous forest and open upland oak-pine forest (Hamel 1992).] Ovenbird, mentioned earlier is also tied in part to this habitat. Trends for these species will be evaluated along with trends in total acres, age-class distribution, and levels of restoration and maintenance activities in this forest type to provide a more complete picture of effects of management on this community.

Mid- and Late-Successional Pine and Pine-Oak Forests: Pine forests have been in serious recent decline on the DBNF as a result of southern pine beetle epidemics and the lack of fire needed to maintain their dominance. Therefore, they will be the focus of ecological restoration and maintenance on some portions of the Forest. The pine warbler (*Dendroica pinus*) is closely associated with pine and pine-oak forests, generally occurring only where some pine component is present. Therefore, it is an appropriate indicator of the effects of management in restoring and maintaining pine forests. This species does not discriminate as to the condition of pine stands relative to mid and understory, however, and would indicate little more than the presence of pine.

Other bird species that may be associated with desired fire-maintained conditions were deemed unlikely to be present in sufficient numbers to serve as MIS. Understory plant species also were considered and found to be too universal in association to be appropriate MIS. Therefore, pine warbler and various habitat-based elements, such as amount and effectiveness of prescribed burning, will be used to indicate effects of management on species associated with this community.

Woodlands, Wooded grasslands/shrublands, and Grasslands: Historic woodland, wooded grasslands/shrublands, and grassland communities on the DBNF will be the focus of restoration efforts to reduce tree cover and restore periodic fire (see Campbell et al. 1991, Delcourt et al. 1998, Delcourt, 2002, Ison 2000, Owen 2002 for discussions related specifically to the Forest area and Cumberland Plateau/Appalachian Provinces). Over time, these activities are expected to create grass-dominated understories. Indian grass (*Sorghastrum nutans*) and other species of native warm-season grasses were considered as MIS because they can be indicators of open habitats and conditions associated with frequent fire. However, these species occur along roadways, in utility rights-of-way, and old fields where only mowing maintains them. A community approach to monitoring in fire-maintained areas will be used instead. The field sparrow (*Spizella pusilla*) is selected because of its association with scattered saplings or shrubs in tall weedy or herbaceous cover (Hamel 1992). In addition, chipping sparrow (*Spizella passerina*), Northern cardinal (*Cardinalis cardinalis*), summer tanager (in part), and Northern bobwhite (in part) are selected as MIS for this group of habitats. Chipping sparrow is associated with the more open pine and pine-oak portion of this habitat group (Hamel 1992). Northern cardinals are associated with the open shrubby/brushy portion of this habitat group (Hamel 1992). Although Northern cardinals may occur in any forest type and condition on the DBNF, bird survey data on the Forest indicate they are most common in the open, brushy areas. Summer tanager is discussed above in the upland oak and oak-pine section. Since this species tends to inhabit the more open stands, it also is associated with the oak and oak-pine (also pine-oak and pine to some extant) woodland portion of this habitat group. Northern bobwhite is discussed above in the demand section. They are associated with all of the conditions in this habitat group but usually in the most open canopy areas. All of these species may be effectively monitored using established protocols. These species will help indicate community response to efforts to maintain and restore this community. Monitoring will focus on presence of these species within restoration areas.

Early-Successional Forest: The yellow-breasted chat (*Icteria virens*) was selected as the most appropriate MIS to represent general early-successional forests. This species is closely associated with this habitat condition on the Daniel Boone National Forest based on bird survey data from the Forest. Eastern towhee (*Piplio erythrophthalmus*) was also selected as an MIS because of its tendency to occur in this habitat type (Hamel 1992), and to maintain continuity from the previous plan into this one. The prairie warbler (*Dendroica discolor*) is selected as the most appropriate MIS to represent early-successional pine forests. Prairie warblers are shrubland nesting birds that require dense forest regeneration or open shrubby conditions in a forested setting. Near optimal habitat conditions are characterized by regeneration, thinned area or patchy openings 10 acres or more in size where woody plants average 2 to 3 meters in height, 3 to 4 cm dbh, and occur in stem densities around 3000 stems/acre (Natureserve 2001). Prairie warbler populations respond favorably to conditions created 3 to 10 years following forest regeneration in larger forest patches (Lancia 2000). Providing a sustained flow of regenerating forests is necessary to support populations of this species. On the DBNF, monitoring data indicate that this species is most closely tied to yellow pine regeneration.

Old-growth: Because most species associated with old-growth conditions are found in late-successional forests, separate indicator species were not selected for old-growth successional stages. Late-successional indicator species as identified in this document would be monitored in both late-successional and old-growth habitats. Abundance of old-growth habitats would be monitored separately to allow evaluation of trends in availability of this habitat condition.

Aquatic Communities: A community-based monitoring approach will be used to assess aquatic habitats, in lieu of designating individual MIS. These approaches look at community composition as an indication of the integrity of aquatic communities. A focus on community composition reduces the variability inherent in looking at an individual species, and thus provides more accurate information on the status of the community and the health of aquatic systems. Therefore, no individual MIS are selected to represent aquatic communities.

In summary, 15 species have been selected as management indicator species for the revised forest plan (Table 2). They will be used to assess effects of alternatives and to help monitor effects of implementing the selected alternative.

Table 2. Management Indicator Species selected for use in the DBNF's 2004 Forest Plan and primary reason(s) for their selection.

Common Name	Scientific Name	Primary reason(s) for selection
Acadian flycatcher	*Empidonax virescens*	Special habitat needs; special interest
Black-throated green warbler	*Dendroica virens*	Ecological indicator (major biological community); special interest
Cerulean warbler	*Dendroica cerulea*	Special habitat needs; ecological indicator (major biological community); special interest
Summer tanager	*Piranga rubra*	Ecological indicator (major biological community); special interest
Chipping sparrow	*Spizella passerina*	Ecological indicator (major biological community); special interest
Northern cardinal	*Cardinalis cardinalis*	Ecological indicator (major biological community); special interest
Field sparrow	*Spizella pusilla*	Ecological indicator (major biological community); special interest
Eastern towhee	Piplio erythrophthalmus	Ecological indicator (major biological community); special interest
Yellow-breasted chat	Icteria virens	Ecological indicator (major biological community); special interest
Ovenbird	*Seiurus aurocapillus*	Special habitat needs, ecological indicator (major biological community); special interest
Pine warbler	*Dendroica pinus*	Ecological indicator (major biological community); special interest
Prairie warbler	*Dendroica discolor*	Ecological indicator (major biological community); special interest
Northern bobwhite [quail]	*Colinus virginianus*	Ecological indicator (major biological community); demand species; special habitat needs
Pitch pine	*Pinus rigida*	Special habitat needs; special interest
White-tailed deer	*Odocoileus virginianus*	Demand species

It may appear that selected MIS are not adequate to represent all species or potential management effects as needed to provide for species viability and forest health as well as diversity. However, of the five categories of MIS listed in the regulations, only one category is to be selected because they are believed “to indicate effects of management activities on other species of selected biological communities” (36 CFR 219.19(1)). The purpose of other categories of MIS are to focus attention on effects of management on T&E recovery, species with special habitat needs “that may be influenced significantly” by management, and to meet public demand for game and non-game species. This appendix clearly documents our consideration of species under each of these categories (see below).

Based on these five categories, it is clear that not all MIS are to serve as “proxies” for other species; some are of direct interest themselves. Regulations make no direct link between species viability requirements and MIS. Use of MIS as the sole or primary means of assessing viability risk is not consistent with the best science, as addressed above. DBNF planners have made no effort to select MIS to represent *all* species or all management effects, but there is no requirement to do so. As indicated above, species viability requirements have been addressed primarily through direct evaluation of all species of viability concern and a mix of monitoring strategies.

Finding species that meet these criteria is more difficult than it might first appear, especially in light of current scientific understanding. When regulations were adopted in the early 1980s, use of MIS was deemed the best approach for addressing biological diversity. Today, their use as the sole or primary means of planning and evaluating biological diversity is regarded as rather simplistic. The vast amount of research and scientific publication over the past 20 years has provided greater insight into ecological interactions and ecosystem functions. There is now a much greater appreciation for the complexity of population responses as well as the limitations of using one species as a “proxy” for whole communities. The inherent difficulties in precisely monitoring populations of many species is also more recognized.

As a result, there has been less emphasis on MIS during this round of planning, while remaining in compliance with both the letter and intent of regulations. At the same time, there has been greatly *increased* emphasis on consideration of viability of many more individual species, and incorporated use of ecologically-based vegetation classification systems, newly developed by The Nature Conservancy and NatureServe. Use of this classification system includes recognizing and protecting rare community types. In addition, rather than focusing on a handful of individual species, our monitoring programs have increased emphasis on observing species groups and communities, such as birds, bats, fish, and rare communities. This approach should provide much better information on more species as well as overall system function. Where appropriate, individual species will be monitored. Work will continue with partners in Forest Service Research and at universities to encourage and support research on key biological issues that are too complex to be addressed DBNF monitoring programs.

This shift in emphasis reflects an understanding of the latest science as well as an increased commitment to biological conservation by the Forest Service and not, as some may suggest, an attempt to avoid these issues.

The same set of MIS is used to evaluate all Alternatives, including the No Action alternative. This alternative is also evaluated with existing MIS (USDA Forest Service 2001b). While each alternative represents a different set of management regimes and objectives, MIS are independent of this. Regulations governing MIS state: “Planning alternatives shall be stated and evaluated in terms of both amount and quality of habitat and of animal population trends of the management indicator species” (36 CFR 219.19(2)). MIS are not actions or outputs, the variables that typically vary by alternative. They are planning tools, used to “indicate” management effects by alternative. Changing MIS with each alternative would greatly reduce their usefulness as constants to compare and contrast effects across alternatives. Such a strategy would be inconsistent with the Forest Service’s reading of regulatory intent. The likely effects upon quantity and quality of habitat as well as MIS population trends are analyzed and disclosed under the appropriate sections of the EIS, in compliance with both NEPA and NFMA.

Species from other taxonomic groups were also considered as MIS. Generalists species from other taxonomic groups should be provided for through coarse filter monitoring using other species. A variety of habitats on the ground should provide an array of usable habitat for these species. Habitat specialists, such as salamanders and many plants, occupying general classes of conditions, e.g., old mixed mesophytic forest or upland oak forest, should again be provided for using the coarse filter approach. By choosing MIS with relatively large home ranges compared to those of other species using the same general habitat, or specific, undocumented or poorly understood microconditions within the general habitat, the likelihood of including these microconditions is increased. Specific, but uncategorized, conditions in many cases have been addressed through management prescription areas. Species ineffectively monitored should be addressed through a combination of coarse and fine filters.

Mammals tend to be either wide-ranging generalists, e.g. white-tailed deer and black bear, or secretive animals that may not be effectively monitored, e.g. spotted skunk. Wide-ranging generalists often may not be effectively monitored because specific agency actions are not easily tied to population trends, and groups of animals or individuals often do not stay in any one area. In addition, the black bear was not considered as a management indicator species because recent research (Mitchell and Powell 2003) indicates their response to managements actions differ according to maturity and sex. The level of monitoring required to differentiate between age, sex, and management actions is beyond the means of the Forest Service. North American elk was not considered as a management indicator species because of its recent arrival (via re-introduction) in Kentucky and its limited distribution on the DBNF. The Kentucky Department of Fish and Wildlife Resources continues to fund research and monitoring projects to learn more about the lifestyle of elk in Kentucky. However, white-tailed deer was chosen a game species MIS. Plants generally fall into three groups, wide ranging generalists for which management actions are not demonstrably tied to populations; uncommon, but widely distributed habitat specialists for which specific management actions are unknown; and species for which effective monitoring methods are not demonstrated.

Most amphibians and reptiles do not meet the criteria of appropriate MIS because they often require a sampling effort beyond the Forest Service’s current capability. Although some researchers make a case for salamanders as indicators of ecosystem integrity (Welsh and Droege 2001), salamander population trends in the Southern Appalachians high sampling variability can make monitoring particularly difficult (Hyde and Simons 2001). Our inability to count them with precision makes inferences on relationships between population trends and habitat changes unreliable and difficult. The Forest Service is working closely with cooperators to improve, develop, and standardize survey protocols for both amphibians and reptiles so that effective monitoring programs can be established and expanded. Currently, inherent limitations to monitoring this group make them generally ineffective as MIS.

Salamanders, often used as indicators of intact older forest, are difficult to monitor effectively. Often cited literature, in particular Welsh and Droege (2001), support the usefulness of salamanders as

MIS. The Forest Service has reviewed this literature and recognizes the validity of the general points presented. However, other evidence from the scientific literature highlights inherent difficulties in monitoring trends of salamander populations. Based on a study of salamander monitoring methods conducted in the Great Smoky Mountains National Park, Hyde and Simons (2001) concluded "[t]he extreme variation inherent in all the methods we examined (CV > 100%) severely limits their utility for population monitoring" and "[t]he feasibility of monitoring terrestrial salamander populations over large geographic areas using current methodologies remains suspect." They also state "the development of reliable sampling methods…is essential before extensive monitoring programs are established." In addition, the complex variations between species would preclude selecting salamanders as a group, as some commenters suggest. According to Hyde and Simons, "[b]ecause spatial and temporal patterns of distribution and abundance are species-specific, salamander population data should be considered on a species-by-species basis." Until some of the uncertainties related to monitoring methods are worked out, Forest Service planners regard salamanders as ineffective MIS.

Simply because salamanders or reptiles have not been selected as MIS does not mean they will be ignored. Several salamanders and reptiles have been analyzed as species of viability concern. Status of their habitats and/or populations will be monitored during plan implementation (see Monitoring Summary Table, Forest Plan Appendix D, monitoring questions 1, 2, 4, 7). In addition, general effects of management activities on salamander populations have been well documented in the scientific literature. Management actions (such as overstory removal and prescribed burning) that result in drying of litter and upper soil layers are detrimental to most salamanders and their habitats. The 2004 Forest Plan includes strategies for maintaining moist-soil habitats, such as emphasizing mature forests in riparian corridors and protecting seeps, springs, bogs, fens, seasonal ponds, and prime coves as rare communities. A relatively small proportion of mesic sites is expected to be negatively impacted from management activity, while the majority of these sites are expected to continue to age and improve in quality (with some serious exceptions due to the expected near-future invasion of the hemlock wooly adelgid, an invasive non-native insect). For reptiles, the Forest Plan includes strategies for maintaining grassland, open forest, woodland, and wooded grassland as well as appropriate riparian habitat. See the Biological Elements and Resource Program sections of the FEIS for more details.

The 1985 Forest Plan listed seven fish species as aquatic MIS, but they were determined not to have fulfilled their intended purpose. It was also recommended that the MIS fish be replaced with aquatic macroinvertebrates as measured through indices (USDA Forest Service, 2001b).

Regulations found at 36 CFR 219.19 stipulate that MIS populations should reflect management activity and when these species can be effectively monitored. The DBNF's patchwork ownership pattern includes numerous areas of private or other agency ownership within the various 5th level HUCs (watersheds) that cover the Forest. In over 30 of the 49 watersheds found on the Forest, National Forest System land account for less than one-half of the land. This fragmented ownership, combined with the relatively mobile nature of fish and the influence of non-National Forest System lands on the watersheds, make the effects Forest Service management on fish very difficult, if not impossible, to discern. On smaller watersheds where the DBNF manages the headwaters, the effects of management actions on aquatic organisms can be determined if the organisms have local home ranges.

Aquatic macroinvertebrates (largely insects), known to be sensitive to water quality and sedimentation, are limited in their movement. This makes them ideal ecological indicators for the aquatic system. However, individual species are not as effective at reflecting aquatic health as are indices based on aquatic macroinvertebrates communities. In addition to monitoring physical and chemical parameters of the aquatic system, the DBNF will track indices based on aquatic macroinvertebrate assemblages that reflect the community structure and function,. Because these biological indices are not individual, or even groups of, species, they do not strictly fit the CFR 36 219.19 definition of ‘management indicator species.’ However, they fulfill all the criteria for MIS and are more effective than any individual or small group in reflecting the health of an aquatic system. Such indices reflect changes in populations of various species, populations that are easily influenced by management activities (see below). This meets the fundamental clause “because their population changes are believed to indicate the effects of management activities” (36 CFR 219.19 (a)(1)). Aquatic macroinvertebrates as a group are widely distributed throughout the DBNF. They can be found in nearly every stream and body of water on the Forest. Indices based on macroinvertebrate assemblages provide a numerical representation of the community structure and function, accurately reflecting the health of the aquatic habitat being evaluated. Such indices can be reliably compared from one stream to the next. They can be used to not only indicate clean or adversely impacted streams but can reflect the degree of impact. When combined with physical and chemical data, the source and/or cause of adverse impact can often be determined. This will also greatly facilitate the monitoring of many of the threatened and endangered aquatic species on the DBNF.

Fish communities will be sampled at the time of macroinvertebrate sampling. Evaluation will consist of a biotic integrity index.

SEDIMENT YIELD AND CUMULATIVE EFFECTS MODEL

A sediment yield/cumulative effects model was developed (Clingenpeel 2002) to estimate sediment yields and analyze the cumulative effects of proposed management actions on water quality. More technical assumptions associated with the model can be found in the process paper (Clingenpeel 2002) with a citation found in the list of references. The process provided a means to systematically evaluate water quality conditions for 5th level watersheds covered in whole or in part by the Forest Plan. The process also provided results that aided in aquatic viability analysis at the community scale.

The model first determined the current condition of each 5th level watershed (all lands). This was accomplished by ranking on a relative scale (1 –5) the condition of each watershed in terms of sediment, point source pollution, stream temperature and altered stream flow. Sedimentation was assessed based on current land uses represented in each watershed. Estimates of current sediment were expressed as a percent increase above a baseline condition (forested, with no roads). Point source pollutants were expressed as a density (points per square mile). Temperature was assessed based on the road density in the riparian area and the percent of the riparian area forested in the 1970’s and 1990’s. Altered stream flow was evaluated based on the number of dams, road density in the riparian area and average density of strip mines (1970’s and 1990’s) within each 5th level watershed.

Major assumptions associated with the model included:

- Sediment yield is an appropriate surrogate for determining cumulative impacts to water quality.
- Fifth level watersheds are the appropriate scale of analysis for cumulative effects to water resource.
- Appropriate erosion coefficients from Dissmeyer and Stump (1978) approximate erosion rates from land use activities on CNF lands.

The model provided the following information:

- Estimates of the current sediment yield within 5th level watersheds covered in total or partially by the Forest Plan.
- Estimates of sediment yield attributable to Forest Service activities by alternative and planning period.
- Estimates of cumulative sediment yields for entire 5th level watersheds (all ownerships) by alternative and planning period.
- An index of watershed health for 5th level watersheds based on the percent increase in sediment yield above a baseline condition. The initial watershed index is determined by using the relative abundance of locally adapted species with respect to sediment increases. The score is modified based on physiographic province, percent of national forest ownership within the watershed, percent of the riparian that is forested, and road density within riparian.

INCORPORATING THE SCENERY MANAGEMENT SYSTEM

The Visual Management System, introduced in 1974 as a planning and management tool for National Forests, established an inventory procedure to track and maintain visual quality. In June 1995, Landscape Architects and Planners from Region 8 and Region 9 were introduced to a new handbook which revised the Visual Management System and renamed it the Scenery Management System.

The Scenery Management System (SMS) replaces Volume II, Chapter I, of the Visual Management System (VMS) also known as “The Big Eye Book.” The rest of the VMS Volume II chapters remain current. While the system remains essentially intact, still supported by current research, terminology has changed, and the system has been expanded to incorporate updated research findings. The SMS differs from the VMS in that it increases the role of constituents throughout the inventory and planning phases, and it borrows from and is integrated with the basic concepts and terminology of Ecosystem Management. The SMS provides for improved integration of aesthetics with biological, physical, and social/cultural resources in the planning process.

There are similarities in the two systems. The following compares the terminology of the systems:

Table B - 16. Comparison of the Terminology between the Visual/Scenery systems.

Scenery Management System (SMS)	Visual Management System (VMS)
Landscape Character	Characteristic Landscape
Concern Levels	Sensitivity Levels
Distance Zones	Distance Zones
Scenic Attractiveness	Variety Class
Constituent Information	New
Scenic Classes (1-7)	New
Scenic Integrity Objective	Visual Quality Objective
VH (Very High Scenic Integrity)	Preservation
H (High Scenic Integrity)	Retention
M (Moderate Scenic Integrity)	Partial Retention
L (Low Scenic Integrity)	Modification
VL (Very Low Scenic Integrity)	Maximum Modification
Scenic Integrity Level 9 same as above, except includes UL (Unacceptable Low)	New
Existing Scenic Integrity	Existing Visual Condition

In late 1995, the Daniel Boone National Forest Landscape Architect began to update existing Visual Management System maps and convert them to Scenery Management System Maps. Inventory components were completed using a variety of field and in-office methods to reverify and/or update old inventories. As much of the original VMS inventory data as possible was utilized. District and public input was obtained and new information was field checked before mapping. In *The Boone Planner* of April 1997, the public was asked to provide input on “special” places in the National Forest. Comments received were checked on the ground and mapped as appropriate. The Initial Inventory was completed later in 1997. This initial mapped inventory was entered in a computer database in 2001.

The Daniel Boone followed the lead of the five southern Appalachian national forests in determining the Scenic Integrity Levels (SILs) and Landscape Character Themes (LCTs) for each prescription area. Using the Land Class, SIL’s and LCT’s matrix, acres of Scenic Integrity Objectives (SIOs) were assigned prescription areas. Chapter two and three display the Scenic Integrity Objectives (SIOs) and Landscape Character Goals (LCGs) by alternatives. The assigned goals and objectives are based upon the 1997 inventory. When an activity is planned for a specific site, the area around the activity will be re-evaluated and a final SIO and LCG will be assigned and placed on the inventory map.

ECONOMIC AND LOCAL GOVERNMENT IMPACT ANALYSES

The purpose of this portion of Appendix B is to provide interested readers with additional details regarding the social and economic analyses. This section does not provide sufficient information to replicate the analysis. For that level of detail, the companion specialist reports contained in the administrative record should be consulted.

Economics was not a significant issue in the Plan revision. However, when they were relevant, economic data became a factor in decision-making. Economic data were used as required to make informed decisions. Data used throughout the FEIS were deemed reliable or adjusted based upon updates to become the most reliable at the time.

36 CFR 219.12(g)(1) requires an analysis of expected outputs during the planning period. It suggests use of outputs, which include marketable goods and services as well as non-market items, such as recreation, and wilderness use, wildlife and fish, protection and enhancement of soil, water, and air, and preservation of aesthetic and cultural resource values. Based on these resources, the FEIS undertook to show a present net value as required by 36 CFR 219.

The Forest has discussed in a narrative fashion only the foreseen environmental consequences of the proposed land management alternatives. For resources that can be reasonably valued via market data (e.g. timber, minerals), and for those non-market resources that have estimated values based on Forest Service research, we have presented values using a present net value calculation. For resources that have no values estimated by generally accepted methods, we have chosen to discuss in a narrative fashion in the course of assessing net public benefits.

U.S. Forest Service activities on the DBNF are governed by a large number of rules and regulations designed to mitigate negative impacts or otherwise protect resources. In the planning process, such benefits associated with regulations are seldom quantified in dollar terms. The costs for achieving these benefits come in the form of increased operating costs and reduced timber revenues.

Therefore, an attempt was made in the planning process to fully enumerate the dollar values of all market and non-market benefits as well as the costs that can reasonably be expected to occur due to an alternative in an attempt to provide as much relevant information as possible to aid in making an informed decision.

Option values and existence values are not items suggested to be discussed under 36 CFR 219. These are highly controversial methodologies, which can be of a contentious nature with many publics. The Forest Service has chosen not to use values based on questionable and controversial methodologies and values not specifically required by Forest Service directives.

Many of the “ecosystem services” provided by forested land, such as flood control, purification of water, recycling of nutrients and wastes, production of soils, carbon sequestering, pollination, and natural control of pests; and externalized costs of resource extraction, such as increased rates of death, injury and property damage resulting from accidents involving heavy equipment, log trucks, ORVs and other dangers related to intensive resource use and development, are considered to be effects remote from resource management on the Daniel Boone NF. Their speculative and unforeseen nature does not warrant a consideration in the efficiency analysis required by 36 CFR 219.

The Forest Service does not use its socio-economic analysis quantified measures and indexes as the sole means of displaying alternative inputs (FSM 1970.8(5)). Such a value is one piece of information for the decision maker to use in making selections among alternatives. Other resources that are impacted are discussed qualitatively. Their consequences in forest management are decided along with the monetized resource in arriving at an alternative that maximizes net public benefits. After reviewing the planning documentation and comments from the public participation, the determination of the best alternative, which maximizes public net benefits, is left to the judgment of the decision maker.

THE MODELS

Economic effects to local counties were estimated using an economic input-output model developed with IMPLAN Professional 2.0 (IMPLAN). IMPLAN (Impact Analysis for Planning) is a software package for personal computers that uses the latest national input-output tables from the Bureau of Economic Analysis. The software was originally developed by the Forest Service and is now maintained by the Minnesota IMPLAN Group, Inc (MIG). Data used for the impact analysis was from secondary data for those counties considered to be in the forests impact areas. The assumption used in this modeling process was that the impact area comprised the counties within the forests' designated county boundaries. The data source used in developing the models for impact purposes was the most recent county data available from MIG (1998). County data is used in the model to develop one impact response coefficient for each resource or activity in the analysis area.

Input-output analysis gives estimates of employment and income for an increase in final demand on certain sectors of the economy. For Forest Service timber, for example, we have looked at the saw mill and pulpwood industries where our timber goes as the first processing step in manufacturing. Impacts include all those industries initially impacted as well as those industries linked with supplying inputs to production, as well as workers in those industries who spend wages in their households (known as direct, indirect and induced effects, respectivly). Thus, the impact assumes a new demand is made on the economy and estimates what this new increase in final demand will mean in employment and income to that economy. Input-out put modeling (an efficiency analysis, which tells how income and jobs are distributed throughout and economy for a given economic impact) has nothing to do with benefit-cost (an efficiency analysis, which estimates how efficient monies are spent on investment activities.

Someone who is unfamiliar with IMPLAN cannot readily perform input-output analysis with IMPLAN. A detailed explanation of every step in building the model and constructing individual resource and activity impact files was not made a part of this appendix. To know the procedural process for running IMPLAN, refer to "IMPLAN Professional User's, Analysis Guide and Data Guide", Minnesota IMPLAN Group, Inc., 1997, which is part of the Process Records of each forest. The Minnesota IMPLAN Group also offers training classes for model usage.

Important assumptions have been documented in the FEAST electronic spreadsheet, which links IMPLAN response coefficients with resource outputs, is part of the Process Records. Data sources have been described in this appendix.

DEPENDENCY ANALYSIS

The IMPLAN model was used to assess the economic dependencies of the planning area. Economic dependency is a way of assessing the strength of regional or local economies. Regional economies generally depend on their exports to sustain most local income and employment. Based on this data, it is reasonable to estimate economic dependency by examining an area's export base. The export base analysis done for this EIS measured the total contribution of one sector, or industry to the economy. Industries can import and export similar commodities. Those industries having more exports than imports are considered "basic", and thereby allow "new" money to enter the economy. Basic industries allow an economy to grow.

DIVERSITY ANALYSIS

Using IMPLAN employment and income reports, forest planners illustrated the relative importance of major sectors and industries, such as wood products, and tourism. Employment, industrial output, and total income to workers and proprietors were contrasted to the total for the entire forest economy to gauge the percentage relationship between the two. Using IMPLAN models from two years (1985 and 1996) a change in economic characteristics is illustrated.

The Shannon-Weaver Entrophy Indexes were also used to show relative diversity of counties and state. This process allows a relative measure of how diverse a county is with a single number. The entropy method measures diversity of a region against a uniform distribution of employment where the norm is equi-proportional employment in all industries. All indices range between 0 (no diversity) and 1.0 (perfect diversity). These two extremes would occur when there is only one industry in the economy (no diversity) and when all industries contribute equally to the region's employment (perfect diversity). In most cases diversity would be registered somewhere between 0 and 1.0. Another factor affecting the magnitude of the index is the number of industries in a local economy; the greater number the larger the index.

As it is applied to the regional estimate of employment data, the entropy measure of industrial diversity ***D*** is defined as:

$$D(E_1, E_2, \ldots E_n) = -\sum_n E_i \log_2 E_i$$

where

n = the number of industries, and

E = the proportion of total employment of the region that is located in the ***i***th industry.

The indices contained in these databases have been normalized with respect to the maximum possible index for a given domain of industries (n) so that comparisons can be made between indices for 4-, 2- and 1-digit SIC aggregations. As a result, all indices range between 0 (no diversity) and 1.0 (perfect diversity). Specifically, the indices in these databases were computed as:

$$D(E_1, E_2, \ldots E_n) = (-\sum_n E_i \log_2 E_i) / MAX(D(E_1, E_2, \ldots E_n))$$

where

n = 528 (4-digit SIC), 70 (2-digit SIC), or 12 (1-digit SIC).

Two important properties of the index are:

(1) The maximum value of ***D*** is attained when the ***E*** are all equal. This is the case where the region is totally diversified in the sense that all industries contribute equally to the region's employment. Also, the greater the number of industries sharing the region's economic activity, the greater the value of D.

(2) ***D*** = 0 when only one of the ***E*** = 1 and the remaining are 0. This is an extreme case where the economic activity of a region is concentrated in only one industry; therefore, economic diversity is totally absent.

FOREST CONTRIBUTION AND ECONOMIC IMPACT ANALYSES

An impact analysis describes what happens when a change in final sales (e.g., exports and residents) occurs for goods and services in the model region. Changes in final sales are the result of multiplying production data (e.g., Metric tons of stone or recreation visitor trips) time sales. Economic impacts were estimated for 2000, using the expenditure data for recreation, wildlife and hunting (U.S. Forest Service's National Visitor Use and Monitoring data, (NVUM), and the Fish and Wildlife Service's wildlife use data, respectively); stumpage estimates for timber, and market prices for minerals (provided by the U.S. Minerals Management Service. Daniel J. Stynes and Eric White, Michigan State University, July 2002, used NVUM data to estimate spending profiles of recreation users. The USDA Forest Service Inventory and Monitoring Institute, Ft. Collins, CO estimated spending profiles from the 1996 U.S. Fish and Wildlife Services wildlife data. Recreation visitor trips were derived as an aggregate of all recreation activities as determined by the 2002 NVUM survey on the Daniel Boone National Forest. From this total amount of trips, the Forest disaggregated recreation into Resident and Non-residenttrips for Day Use, Overnight Stay On and Off the National Forest Use.

Impacts to local economies are measured in two ways: employment and total income. Employment is expressed in jobs. A job can be seasonal or year-round, full-time or part-time. The income measure used was total income expressed in 2000 dollars. Total income includes both employee compensation (pay plus benefits) and proprietor's income (e.g., self-employed).

DATA SOURCES

The planning area IMPLAN models were used to determine total consequences of dollar, employment, and income changes in selected sectors. Because input-output models are linear, multipliers or response coefficients need only be calculated once per model and then applied to the direct change in final demand. A Forest Service-developed spreadsheet known as "FEAST" (Forest Economic Analysis Spreadsheet Tool) was used to import the IMPLAN impact results (response coefficients) to each alternative, expressed in units of output. FEAST transforms the dollar impact for a given industry from IMPLAN to the resource output units, obtained from SPECTRUM (e.g. ccf for timber) or other sources such as NVUM for recreation and wildlife use. The multiplication of resource outputs and the IMPLAN response coefficeints within FEAST yields a specific employment and dollar output for each resource or activity. Specifications for developing IMPLAN response coefficients and levels of dollar activity are stated below.

TIMBER

Sales Data – Sales data was determined by using timber values multiplied by estimated production levels for each alternative.

Use of the Model – Hardwood and softwood sawtimber were processed through the sawmill industry. In the absence of a pulp mill in the local economy roundwood was assumed to be exported out of the analysis area. Impacts represent the economic activity occurring in all backward linking sectors associated with the final demand output of the timber industries described above.

IMPLAN showed, that for every $1 million of total timber production in the forest impact area, a given level of dollar value of logs going into the mill result in this impact. Some of this output may be exported and generate new money for the local economy.

OTHER RECREATION & WILDLIFE/FISH

Expenditure Data – Recreation and Wildlife and Hunting trips were derived from the National Visitor Use and Monitoring survey, 2002 (NVUM) that is done for one-quarter of national forests each year. The resulting Survey yielded trips for resident and non-resident Day, On National Forest Overnight use, and Off National Forest Overnight Use. These use metrics were entered into FEAST to link with IMPLAN impact response coefficients to yield an impact for recreation and wildlife resources.

While some analysts may not include resident participation in local economy impacts because there may be substitution opportunities for local residents to spend their discretionary dollar, we decided to include resident expenditures in the local economy with the caveat that these expenditures were "associated" with the impacts not "responsible" for causing the impacts. The statement -is made that impacts are "associated" with recreation and wildlife resource impacts rather than "caused" by these impacts because local recreation users have many choices in an impact area for recreation. If some people choose not to recreate on national forest level land, they may recreate in another manner such as go to sporting events or a movie. The dollars would still be spent in the local economy causing a similar impact, but the provider of recreation would be a different party. Local residents are defined as recreation users within 50 miles of the forest boundary.

FEDERAL EXPENDITURES & EMPLOYMENT

Expenditure Data –A Forest budget was estimated for each alternative, and these estimates were used for forest expenditures, some of which had local economic effects. Total forest obligations by budget object code for FY 2000 were obtained from the National Finance Center and used to identify total forest expenditures. The proportion of funds spent by program varied by alternative according to the theme for that alternative. The forest staff based on examination of historical Forest Service obligations estimated Forest Service employment.

Use of the Model – To obtain an estimate of total impacts from Forest Service spending, salary and non-salary portions of the impact were handled separately. Non-salary expenditures were determined by using the budget object code information noted above. This profile was run through the model for non-salary expenditures per one million dollars, and the results multiplied by total forest non-salary expenditures. FEAST was again used to make the calculations. Local sales to the federal government are treated in the same manner as exports.

Salary impacts result from forest employees spending a portion of their salaries locally. IMPLAN includes a profile of personal consumption expenditures for several income categories; the average compensation for an employee on the Daniel Boone National Forest fell in the category of $30,000-$39,999.

REVENUE SHARING – 25% FUND PAYMENTS

Expenditure Data – Until September 30, 2001, Federal law required that 25% Fund Payments be used for only schools or roads or both. A split of 50 percent for schools and 50 percent for roads was used. One profile of expenditures was developed from within the county forest boundary model for 1) the highway construction sector and 2) local educational institutions. Because counties can choose to continue payments under this formula, traditional payments were analyzed (we assumed 50 percent of payments went to roads and 50 percent to education). Should counties choose fixed payments under the new law, the impacts would not vary by alternative. The impact of the fixed payment was not calculated.

Use of the Model – The national expenditure profile for state/local government education (schools) and local model estimates for road construction (roads) are provided within IMPLAN. One million dollars of each profile was used to obtain a response coefficient for these Forest Service payments to impact area counties. Sales to local government are treated in the same manner as exports.

OUTPUT LEVELS

Output levels for each item listed above can be viewed in various Forest FEAST spreadsheet files contained in the process records. These amounts are also located in the corresponding resource sections of the FEIS.

The following Prices were used in the Impact analysis:

In 1998 Dollars

Coal	$27.11/metric ton
Natural gas	$2.39/mcf
Crude oil	$11.67/barrel
Dimension stone	$3.26/metric ton

	Non-resident	Resident
General hunting	$100.15/trip	$12.70/trip
General fishing	$126.27/trip	$21.36/trip
Non-consumptive fish & wildlife	$ 76.70/trip	$ 9.62/trip
Recreation on NF-Day Trip	$43.65/trip	$30.13/trip
Recreation Overnight-Off NF	$204.70/trip	$114.58/trip
Recreation Overnight-On NF	$159.99/trip	$111.13/trip

Note: These prices were inflated to 2000 dollars in the FEAST spreadsheet. 1998 dollars were used in IMPLAN because the basic IMPLAN data was in 1998 dollars.

FINANCIAL AND ECONOMIC EFFICIENCY ANALYSIS

Financial efficiency is defined as how well the dollars invested in each alternative produce revenues to the agency. Economic efficiency is defined as how well the dollars invested in each alternative produce benefits to society. Present Net Value (PNV) is used as an indicator of financial and economic efficiency.

The Daniel Boone National Forest used a Microsoft Office Excel electronic spreadsheet to calculate PNV for each alternative over a 50-year period. A 4 percent real discount rate, prescribed by Forest Service Handbook (FSH) 1909.17, was used. Decadal and 50 year cumulative present values for program benefits and costs as well as present net values are the product of this spreadsheet. For each decade, an average annual resource value was estimated, multiplied by 10 years, and discounted from the mid-point of each decade.

The financial values for timber from average 2000 stumpage prices; for minerals from market prices for minerals from the Minerals Management Agency; and prices for recreation and wildlife from RPA updated to 2000 dollars and transformed to NVUM unit measurements. All values are in 2000 constant dollars.

For the recreation and wildlife values, a conversion factor of 1.325 was used to convert from RVDs to "Visits." This factor was determined by taking the average of hours for a site visit on the Daniel Boone National Forest, which was 15.9 hours per site visit. 15.9 was divided by 12 (number of hours in an RVD) to get the value of 1Visit = 1.325 RVDs. This factor was multiplied by the 1989 price of an RVD. For example, Hunting had a 1989 price of $33.27/RVD. This was increased by a factor of 1.325 to equal $44.08/ Visit. This 1989 RPA value per visit was increased to the value of a 2000 visit in 1989 dollars using the predicted annual increase in value of each RPA recreation activity ($44.08 X (1.0018)^11) = $44.96). This price was then inflated by the Gross National Price Deflator to 2000 dollars (a factor of 1.2887) to yield $57.94/Visit.

The table below displays the economic values that were used for each resource.

Table B - 17. Economic Benefits and Financial Revenue Values

Product	Dollar Value[1]
Timber ($/MCF[2]):	
Saw-softwood	$405
Saw-hardwood	$808
Roundwood- softwood	$5
Roundwood- hardwood	$5
Minerals:	
Crushed stone ($/metric ton)	$3.37
Limestone ($/metric ton)	$4.65
Coal (tons)	$28.01
Natural gas ($/cubic meter)	$0.09
Recreation ($/visit):	
Camping, picnicking, swimming	$17.47
Mechanical travel, viewing scenery	$13.48
Winter sports	$73.72
Resorts	$37.27
Wilderness (backpacking)	$37.16
Other recreation	$107.93
Wildlife ($/visit):	
Hunting	$57.94
Fishing	$115.06
Wildlife watching	$69.06

[1] Timber values based on Forest harvest values; Recreation and Wildlife values based on non-market values in the USDA Forest Service "Resource Pricing and Valuation Procedures for the Recommended 1990 RPA Program", Mineral value taken from historical prices from the U.S. Minerals Management Service

[2] MCF = thousand cubic feet

STAKEHOLDER AND DEMOGRAPHICS ANALYSES

In recent years, the amount and level of conflict over natural resource issues has increased substantially. As a result, much attention has been devoted to increasing our understanding of the dynamics of these conflicts, what they mean for stakeholders and natural resource managers, and what can be done to help managers and stakeholders better understand each other and work together to find ways to resolve, conflicts before they occur.

We attempted to learn of the values, attitudes and beliefs of the neighbors to the Southern Appalachian forests (including the Daniel Boone national Forest), through a random telephone survey. This survey was published under the title "Public Survey Report, Public Use and Preferred Objectives for Southern Appalachian National Forests" Cordell et al. (2002). Copies are located at www.srs.fs.fed.us/trends.